United States Patent [19]

Barnes, Jr.

[11] **3,900,025**

[45] **Aug. 19, 1975**

[54] **APPARATUS FOR DISTRACTING OR COMPRESSING LONGITUDINAL BONE SEGMENTS**

[76] Inventor: **Walter P. Barnes, Jr.**, 830 Wimbish Rd., Macon, Ga. 31204

[22] Filed: **Apr. 24, 1974**

[21] Appl. No.: **463,463**

[52] **U.S. Cl.** ..... **128/92 D;** 128/84 R

[51] **Int. Cl.** **A61f 5/04;** A61b 17/18

[58] **Field of Search**.... 128/92 D, 92 R, 92 A, 92 G, 128/92 E, 84 R, 84 B, 85

[56] **References Cited**

UNITED STATES PATENTS

3,547,113	12/1970	Swanson	128/84 R

FOREIGN PATENTS OR APPLICATIONS

1,051,847	9/1953	France	128/92 D
274,210	5/1914	Germany	128/92 D
1,538,053	7/1968	France	128/92 D

Primary Examiner—Ronald L. Frinks
Attorney, Agent, or Firm—Merriam, Marshall, Shapiro & Klose

[57] **ABSTRACT**

An orthopedic apparatus for selectively distracting or compressing contiguous longitudinal bone segments comprising a first and second support member each of which can be placed longitudinally coextensively adjacent respective bone segments. A first longitudinal bore extends within the first support member for receiving and threadably engaging one portion of a threaded driving rod, and a second longitudinal bore, axially aligned with the first longitudinal bore, extends within the second support member for receiving and threadably engaging another portion of the threaded driving rod. Upon rotation of the threaded driving rod the first and second support members are longitudinally simultaneously adjusted. The apparatus can be inserted into the limb according to standard orthopedic surgical procedures and then mounted adjacent the bone segments after which the support members are periodically adjusted to stimulate the growth of new bone matter between the distracted bone segments. A method for distracting longitudinal bone segments by insertably mounting an adjustable distracting apparatus adjacent longitudinal bone segments and periodically adjusting the apparatus to stimulate a build up of new bone growth between the bone segments.

15 Claims, 14 Drawing Figures

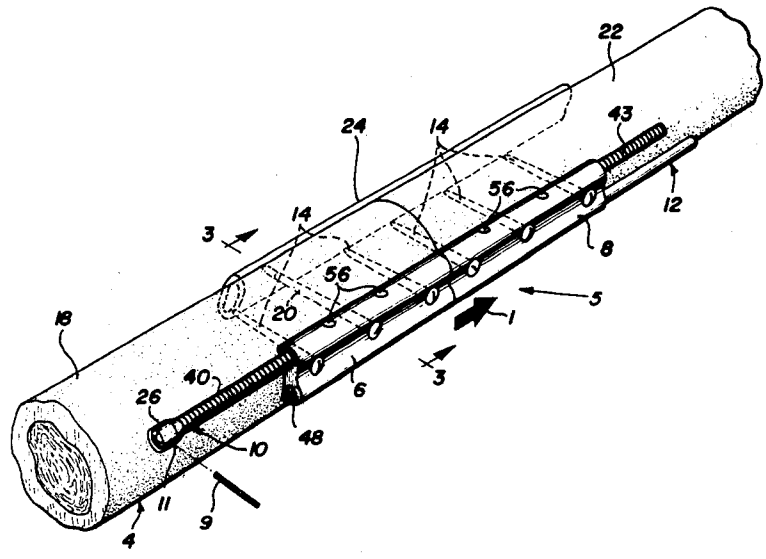


FIG. 1

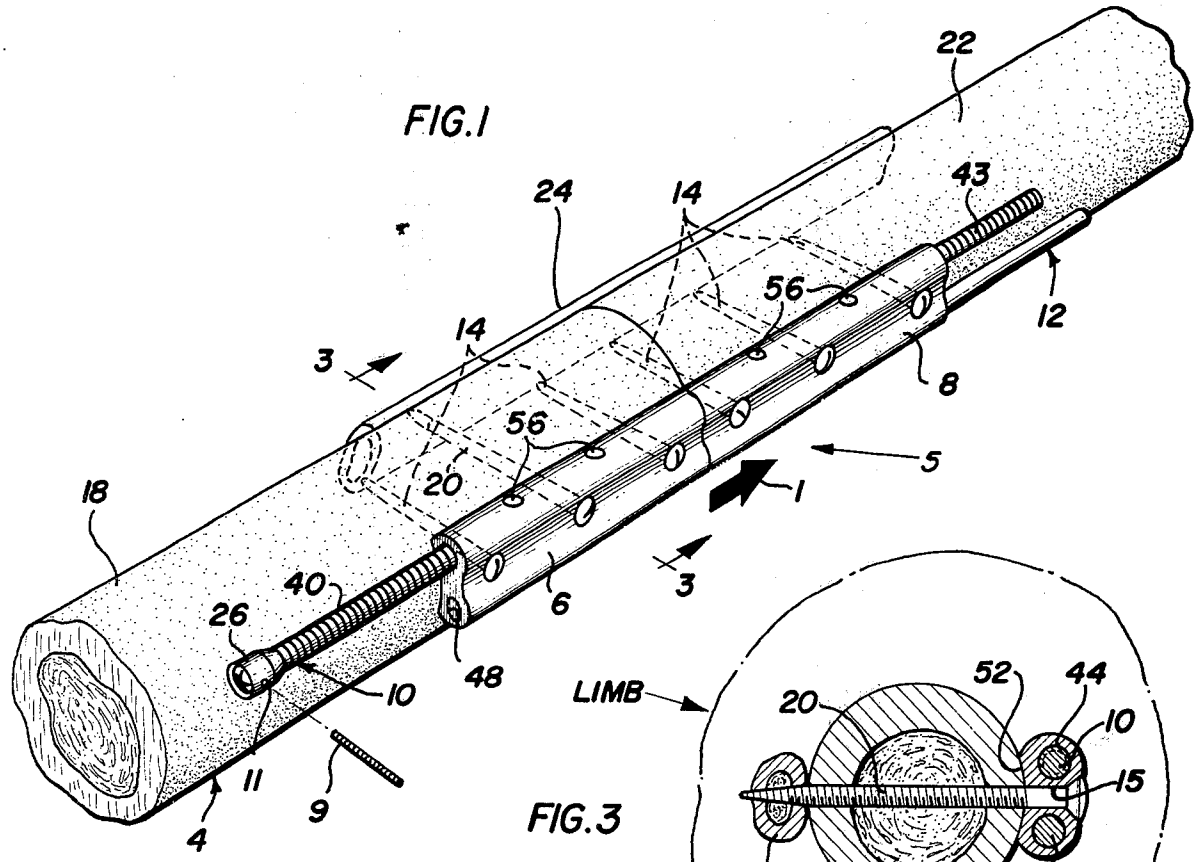


FIG. 3

FIG. 2

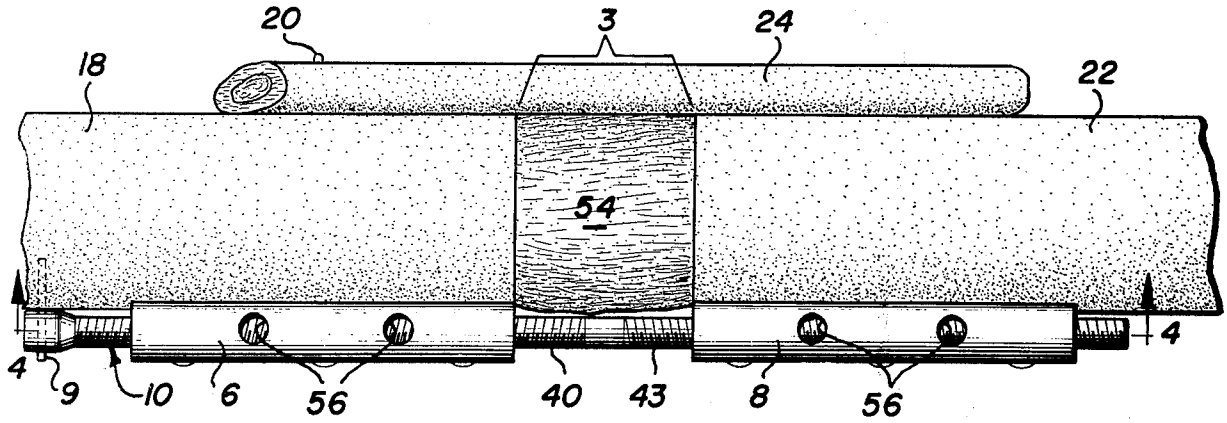


FIG. 4

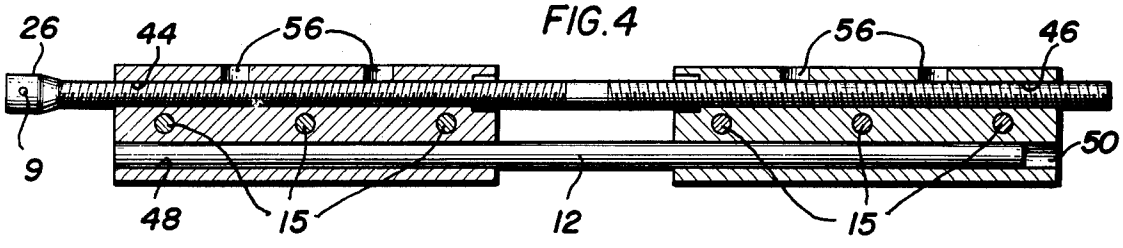


FIG.5

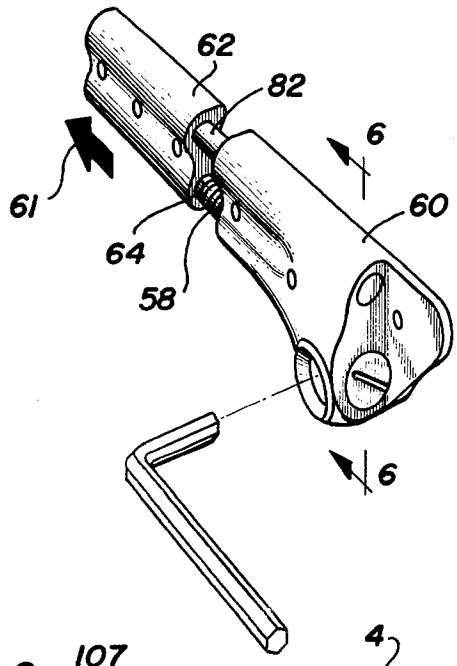


FIG.6

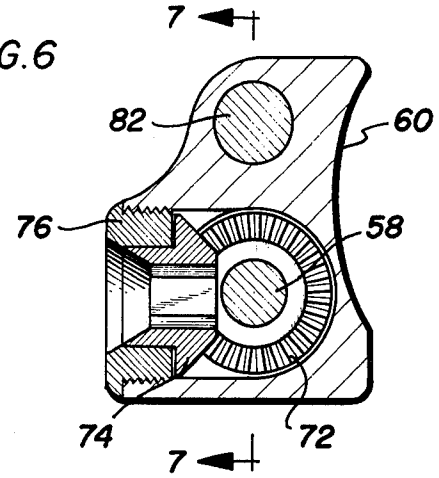


FIG.7

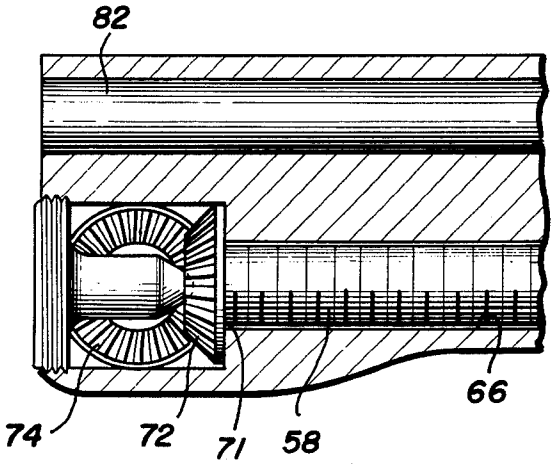
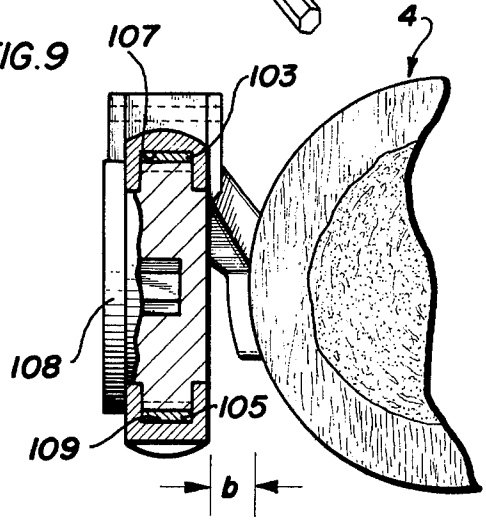


FIG.9



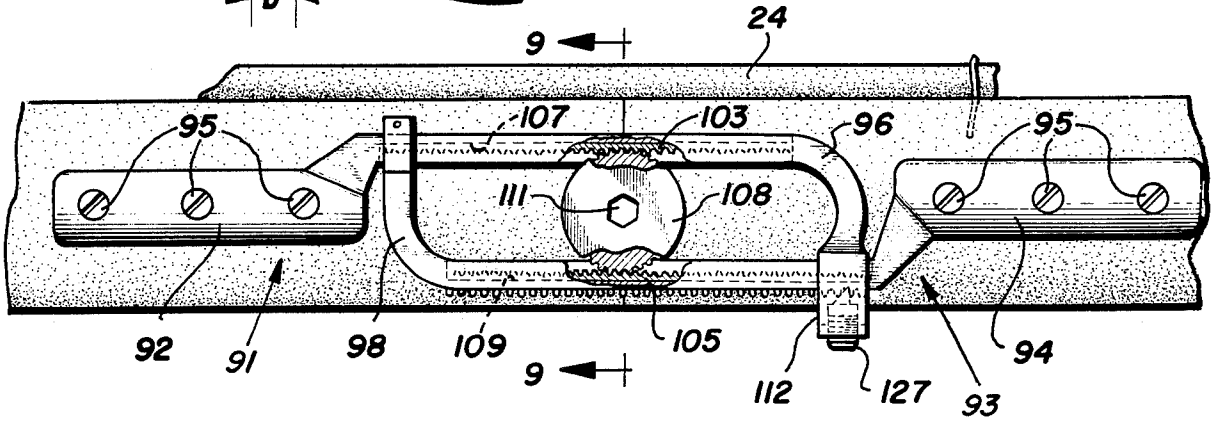


FIG.8

FIG. 10

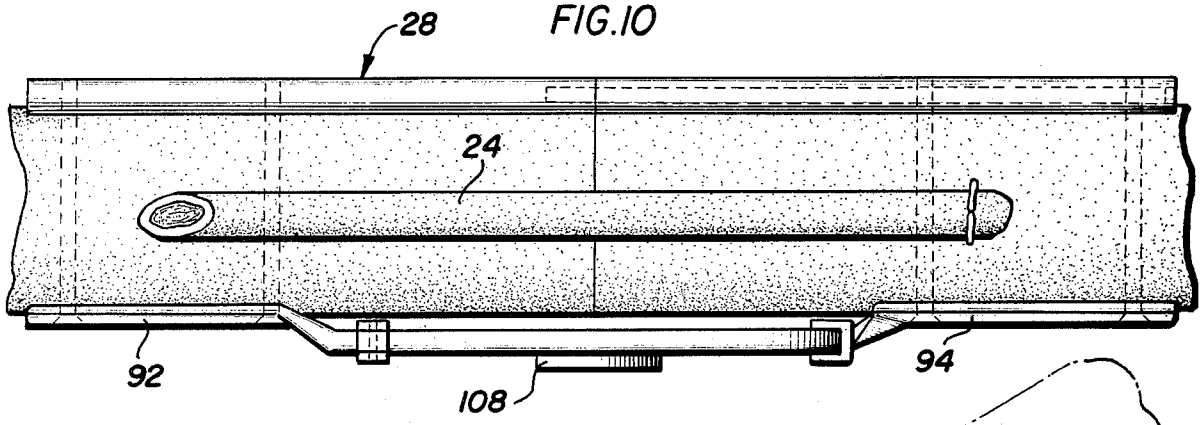


FIG. 11

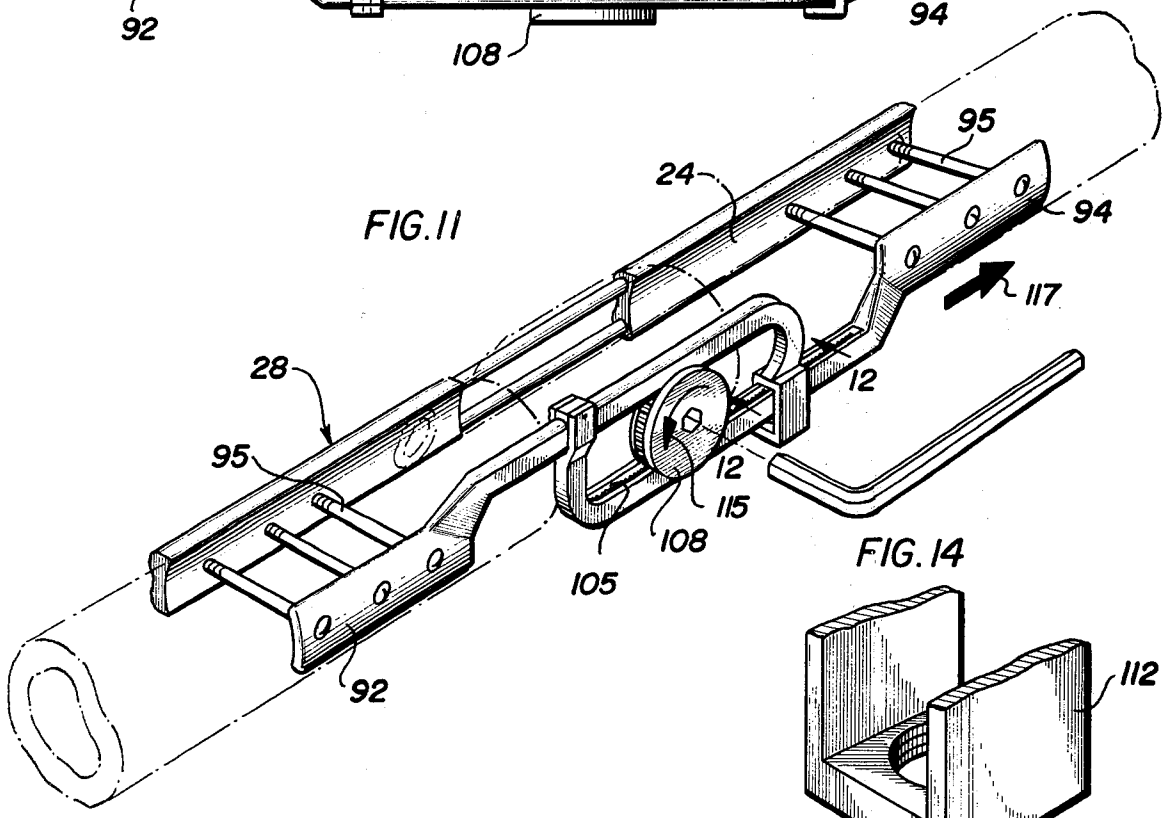


FIG. 14

FIG. 12

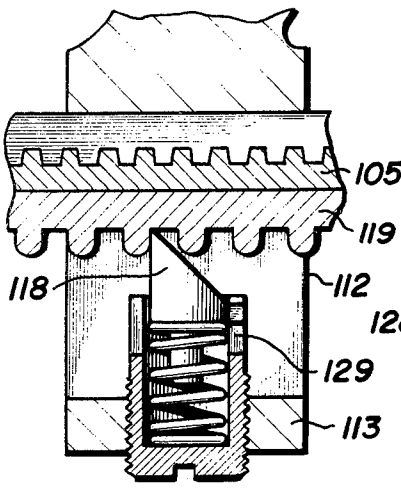
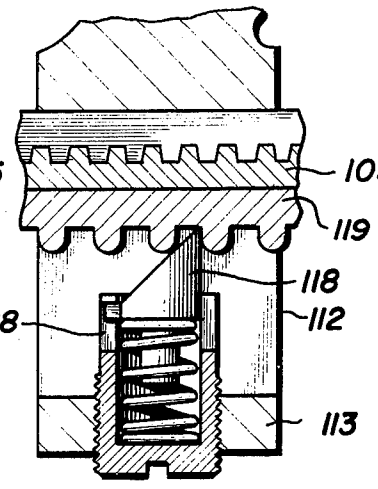
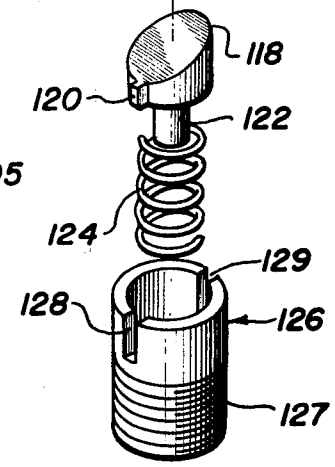


FIG. 13





APPARATUS FOR DISTRACTING OR COMPRESSING LONGITUDINAL BONE SEGMENTS

BACKGROUND OF THE INVENTION

This invention relates to an orthopedic apparatus for distracting or compressing contiguous longitudinal bone segments whereby the apparatus is releasably mounted immediately adjacent the bone segments within the limb. Reference may be made to the following U.S. patents: U.S. Pat. Nos. 1,997,466, 2,024,325, 2,101,889, 2,204,266, 2,238,869, 2,250,417, 2,317,519, 2,391,537, 2,393,694, 2,393,982, 2,687,720 and 3,547,113.

There are known orthopedic surgical procedures, see for example, U.S. Pat. No. 3,547,113, for lengthening a bone, such as the tibia, whereby one of two bone fixation pins is inserted through the limb and bone on either side of the desired bone breaking point. The bone is broken between the pins and a support member is attached to the ends of each fixation pin outside the limb. The support members are then periodically adjusted by means of a threaded connecting rod until the desired distracted bone length is attained. A cast is applied around the limb and pins to hold the bone segments in a substantially axially aligned position and the outside support members are then detached from the pins.

The prior art devices cause many surgical and post operative problems because of their inherent structural deficiencies. None of the prior art devices presently in use or previously mentioned adequately hold the distracted bone segments in rigid axial alignment, because the rigidity of the connection between the support apparatus is dependent upon the rigidity of the bone fixation pins. Thus, not only is angulation and rotation of the bone segments difficult to control when these prior art devices are used, but there is also an increased chance of infection in the open wounds surrounding the pins and pressure necrosis of the skin adjacent the pins. The use of a cast has the disadvantages of causing the patient general discomfort and delaying the time within which the distracted limb may be therapeutically exercised to alleviate muscular tightening, muscle atrophy, and joint stiffness.

SUMMARY OF THE INVENTION

According to the present invention, an apparatus is provided of a size for implantation within a limb in direct contact with a bone for selectively positioning, i.e., distracting or compressing contiguous longitudinal bone segments, comprising a first elongated support member and a second elongated support member, each having means for placement longitudinally coextensively adjacent a respective bone segment. The first and second support members are operatively connected together for adjusting the longitudinal displacement between each support member and for preventing rotational movement of the first and second support members during the longitudinal movement thereof and each have means for releasable attachment immediately adjacent their respective bone segments.

The apparatus is surgically placed within the limb and mounted immediately adjacent the bone segments. The support members may then be periodically adjusted to distract or compress the bone segments.

The invention not only prevents angulation and rotation of the bone segments, but also eliminates the need for a post operative cast, since the bone segments are rigidly held in place by the support members in an axially aligned position. Therefore, there is no chance of infection due to pin tract wounds in the limb, and rehabilitation of the limb may be commenced soon after the operation. The apparatus is lightweight and simple in design, and may be constructed to accommodate almost any bone size.

Other advantages of the invention will become apparent to those skilled in the art upon reading and understanding the further detailed description of this invention.

DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of the preferred apparatus embodiment of the invention in a closed position and mounted on illustrated bone segments within a limb;

FIG. 2 is a top view of the apparatus of FIG. 1 shown in the partially opened position with new bone growth formed between the bone segments;

FIG. 3 is an end sectional view along line 3—3 of FIG. 1 with the limb shown in phantom lines;

FIG. 4 is a front sectional view along line 4—4 of FIG. 2;

FIG. 5 is a perspective view of a second apparatus embodiment of the invention in an opened position;

FIG. 6 is an end sectional view along line 6—6 of FIG. 5;

FIG. 7 is a rear sectional view along line 7—7 of FIG. 6;

FIG. 8 is a front view of a third apparatus embodiment of the invention in a closed position;

FIG. 9 is an end sectional view along line 9—9 of FIG. 8;

FIG. 10 is a top view of the apparatus of FIG. 8;

FIG. 11 is a perspective view of the apparatus of FIG. 8 in an open position;

FIG. 12 is a front sectional view along line 12—12 of FIG. 11 showing the pawl mechanism in a closing position;

FIG. 13 is a front sectional view along line 12—12 of FIG. 11 showing the pawl mechanism in an opening position; and,

FIG. 14 is an exploded perspective view of the pawl mechanism.

DETAILED DESCRIPTION adaptable

Referring initially to FIGS. 1–4, the preferred apparatus embodiment of the invention is shown generally at 5 and is releasably mounted to bone 4 within a limb (see FIG. 3), comprising a first or proximal longitudinal bone segment 18, and a second or distal longitudinal bone segment 22. For purposes of example, reference will be made to the distraction of the femur bone although it will become apparent to those skilled in orthopedic surgery that the invention is adaptable to be used on any relatively long bone and for either distraction or compression, as desired.

As shown in FIGS. 1–4, the apparatus includes a pair of elongated support members 6 and 8. Each support member comprises a rectangular block of stainless steel that has a concave rear surface 52 which permits each support member to lie immediately adjacent to each respective bone segment.

Screws or pin members 14 may be used to releasably mount the apparatus to femur bone 4 through a plural-

ity of screw holes or apertures **15** in support members **6** and **8**. Although the size of the screws may vary according to the size of the apparatus and bone, screws having a diameter of 0.164 inches and a suitable length are recommended so that the apparatus is firmly secured to each of the femur bone segments. Other means for mounting the support members may be utilized, as long as each support member is securely mounted to the bone segments.

Support members **6** and **8** are rigidly adjustably connected together by driving rod **10** and guiding rod **12**. Driving rod **10** not only imparts longitudinal movement to the support members but also maintains substantial longitudinal alignment of the first and second support members. Driving rod **10** comprises oppositely threaded and axially aligned sections **40** and **43**, which are engageable with similarly oppositely threaded bores **44** and **46**, extending within support members **6** and **8**. Bore **44** has an internal left-handed thread corresponding to section **40** of rod **10**, and bore **46** has an internal right-handed thread corresponding to section **42** of rod **10**. This feature permits second support member **8** to move or impart bone segment **22** a longitudinal distance in the direction of arrow **1** in response to the rotational movement of driving rod **10**.

Smooth guiding rod **12** is mounted or fixed within bore **48** in support member **6**, and the opposite portion of guiding rod **12** is slidably engageable or mounted within bore **50** in support member **8**. Guiding rod **12** gives the apparatus rigidity as it is adjustably opened or closed by preventing rotational movement of the first and second support members during the longitudinal movement thereof and maintains each support member in constant axial alignment, thereby eliminating angulation and rotation of the bone segments. Fluid drainage holes **56** are interspaced along the top of each support member.

Small threaded pin or screw **9** is threadably screwed into bore **11**, in socket head **26**, of rod **10** and is then screwed into bone segment **18** after the apparatus is adjusted to insure that the distracted distance remains constant.

In use as a distraction device, the apparatus is inserted into the limb adjacent the bone segments and distraction is accomplished in periodic adjustments to position the bone segments as desired, thereby enabling the formation of new bone growth **54** between the bone segments. The method of distracting the bone segments is hereinafter described in more detail.

FIGS. **5–7** show a second apparatus embodiment of the present invention, comprising first and second elongated support members **60** and **62** that are rigidly adjustably connected by means of threaded driving rod **58** and smooth guiding rod **82**. Guiding rod **82** is connected to support members **60** and **62** in the same manner as shown in the previously described preferred apparatus embodiment and prevents rotational movement of the support members during the longitudinal movement of second support member **62**. An internally threaded bore **64** extends within support member **62** for engagement with one end portion of driving rod **58**; and smooth bore **66**, axially aligned with threaded bore **64**, extends within support member **60** for receiving another end portion of rod **58**.

End **71** of driving rod **58** is mounted to beveled gear **72** for engagement with beveled gear **74** which is rotatably mounted in, bushing **76** within support member **60** (see FIGS. **6** and **7**). When gear **74** is rotated gear **72** rotates which in turn moves or imparts longitudinal movement to support member **62** in the direction of arrow **61**.

FIGS. **8–14** show a third embodiment of the invention wherein support members **91** and **93** comprise first portions, **92** and **94** and L-shaped second portions **96** and **98**, respectively, extending a distance *b* from bone **4** (see FIG. **9**). Second portions **96** and **98** are slidably connected to each other and are operatively connected to each other by means of a rack and pinion mechanism. The interconnection of second portions **96** and **98** inherently prevents support members **91** and **93** from rotating during the longitudinal movement thereof. The rack and pinion mechanism comprises a driving gear pinion **108** having a wrench receiving aperture **111**. Arms **96** and **98** have slots **107** and **109** for first and second gear racks **103** and **105**, respectively. Thus, as shown in FIG. **8**, pinion **108** is locked within arms **96** and **98** and is simultaneously operatively engageable with gear racks **103** and **105**. Support member **94** will longitudinally move or impart in the direction of arrow **117** (see FIG. **11**) when pinion **108** is rotated in the direction of arrow **115**.

A pawl and gear rack mechanism is shown in FIGS. **12-14** which restricts the longitudinal displacement of the support members in a first set of opposed directions while preventing longitudinal movement in a second set of opposed directions opposite the first set. The pawl mechanism comprises a pawl **118** having a flange **120** and a shank **122**. The shank is inserted into spring **124**. Cylindrical housing **126** contains slots **128** and **129** for receiving flange **120**, and is threaded at **127** for insertion into bottom surface **113** of housing **112**. Gear rack **119** is machined out of the bottom surface of arm **98** (see FIGS. **12** and **13**). Thus, pawl **118** is held in a biased position against rack **119** when housing **126** is screwed into position within housing **112**. FIGS. **12** and **13** respectively show the adaptability of the pawl mechanism to be mounted in housing **126** in a first position in which the biased engagement of pawl **118** against rack **119** permits converging longitudinal movement of the support members while preventing diverging longitudinal movement therof, and in a second position in which the biased engagement of pawl **118** against rack **119** prevents converging longitudinal movement while permitting diverging longitudinal movement thereof.

In FIG. **12**, flange **120** is inserted into slot **129** so that the support members may simultaneously converge towards pinion **108**. FIG. **13**, shows flange **120** inserted and, in slot **128** thus permitting the support members to simultaneously diverge away from pinion **108**.

Adaptable with all of the embodiments is a follower apparatus **28**, as shown in use with the third apparatus embodiment in FIG. **10** and **11**, that may be used to increase the rigidity of the coupled bone segments. Follower plate **28** is attached to the medial side of the bone by using longer screws **95**. If the follower is used, onlay graft **24** may be placed on the top of the bone, as shown in FIGS. **8**, **10**, and **11**.

It is to be noted that all of the apparatus embodiments may be used to reduce fractures by simply closing the support members until the fractured segments of bone are joined by compression.

Referring, for example, to the preferred embodiment of FIGS. **1–4**, the method of using the invention for distraction comprises the steps of attaching the proximal

or first support member **6** to proximal bone segment **18.** Onlay graft **24** is not mounted to the bone until after the bone is broken and both support members are in place. Bone **4** is then cut in a step-cut fashion or may be drilled in a transverse direction, and then fractured. Care is taken while fracturing the bone to prevent the tearing of the periosteum. The periosteum is split longitudinally and incised circumferentially at the distal end of the incision to form a split sleeve of periosteum; thus, periostial growth of new bone is not endangered. The distal or second support member **8** is clamped to the distal bone segment after the bone is broken, and the bone segments are then manually axially aligned to correct angulation and rotation of the bone segments which occurs after the bone is broken. Once the bone segments are aligned, the second support member is mounted to distal bone segment **22** in the same manner as the first support member was mounted to proximal bone segment **18.**

To insure complete and rapid ossification of bone segments **18** and **22,** an onlay graft **24** is taken from the fibula and/or ileum during the operation and is loosely affixed to bone segment **4** by using longer screw **20** (see FIG. **3**). The onlay graft is mounted on the medial side of bone **4** bridging gap **3** between bone segments **18** and **22** after the apparatus is adjusted. The onlay graft will become incorporated into new bone growth **54** as the bone ends are completely joined by callus. Screw **20** may be placed in any of the pin receiving apertures **15,** but is preferably placed in the second opening of support member **6.**

After onlay graft **24** is affixed to the bone, the apparatus is adjustably opened by rotating rod end **26** with a screwdriver or the like, until the apparatus and bone segments are distracted approximately three/fourths inch to 1 inch. Onlay graft **24** will slide along the medial side of the bone as shown in FIG. **2.** The wound in the limb is then closed according to standard surgical techniques. After a week to ten days, a small incision is made in the limb over the rod end and rod **10** is rotated again, thereby opening the apparatus another one/-fourth inch to one/eight inch. This procedure may be repeated about every **10** days over a period of 3 to 6 weeks until a maximum distraction of approximately 2 inch to 2 ½ inch is effectuated. The purpose of this periodic adjustment is to insure that the gradual build up of callus or new bone growth **54** will be maintained between the bone segments. Each time the apparatus is adjusted, the newly formed callus is broken up and new callus growth is stimulated. There are some cases, however, in which it may be desirable, in addition to using an onlay graft(s), to fill the gap between the bone segments with cancellous bone grafts in the form of chips.

After the initial operation, the patient may be placed in traction because a cast need not be used. The traction relieves the pressure that the lengthened bone exerts against the knee and hip socket. Note, however, that the apparatus is suitable for use even if a cast is used. While in traction, the patient may exercise the lower portion of the leg in order to further alleviate the socket pressure and to stretch the tight muscles. After the patient is taken out of traction, the limb is placed within a brace until complete ossification of the bone has occurred. The brace will relieve any undue stress on the apparatus and on the new bone before complete bone union occurs. The bone ends will be completely joined after six months to one year. The apparatus and brace may then be removed as soon as a new medullary canal forms.

It is to be noted that the present invention is susceptible to dimensional change depending upon the size of the bone to be distracted. It will be understood that the particular embodiments illustrated and described represent the best form of the invention presently known, and that the invention is not intended to be limited to the particular details so illustrated and described, but encompasses all embodiments falling within the scope of the appended claims.

What is claimed is:

1. An orthopedic apparatus of a size for implantation within a limb in direct contact with a bone for selectively positioning contiguous longitudinal bone segments, said apparatus comprising:

a first elongated support member;

a second elongated support member;

means on said first support member for placement longitudinally adjacent one of said bone segments in direct contact therewith;

means on said second support member for placement longitudinally adjacent another bone segment contiguous to said one bone segment and in direct contact therewith and substantially longitudinally aligned with said first support member;

means for releasably mounting said first and second support members to said bone segments;

a manually operable adjusting member;

means on said first and second support members for imparting longitudinal movement to one of said support members in response to operation of said adjusting member and for maintaining substantial longitudinal alignment of said first and second support members; and,

means for preventing rotational movement of said first and second support members during said longitudinal movement thereof.

2. An orthopedic apparatus as set forth in claim **1,** wherein said placement means on said first and second support members comprises a concave contoured surface on each of said support members.

3. An orthopedic apparatus as set forth in claim **1,** wherein said releasable-mounting means on said first and second support members comprises:

a plurality of pin members for placement within said bone segments; and,

a plurality of apertures in said first and second support members for receiving said pin members.

4. An orthopedic apparatus as set forth in claim **1,** and comprising:

means mounting said adjusting member for rotational movement in response to operation thereof; and,

said movement-imparting means includes means for imparting longitudinal movement in respective opposed directions to said first and second support members in response to rotational movement of said adjusting member.

5. An orthopedic apparatus as set forth in claim **4,** wherein:

each support member includes a first portion and a second portion;

said first portion having means for placement longitudinally adjacent a respective bone segment; and,

said rotation-preventing means comprises means on each second portion for slidably connecting the

second portion of one support member to the second portion of the other support member.

6. An orthopedic apparatus as set forth in claim **5**, wherein:

said adjusting member includes driving gear means; and,

said movement-imparting means comprises first and second gear means on the respective second portions of the first and second support members for simultaneous engagement with said driving gear means.

7. An orthopedic apparatus as set forth in claim **6**, and further including movement-restricting means for permitting longitudinal movement of the support members in a first set of opposed directions while preventing longitudinal movement in a second set of opposed directions opposite of said first set.

8. An orthopedic apparatus as set forth in claim **7**, and comprising:

means for mounting said movement-restricting means in a first position in which said movement-restricting means permits diverging longitudinal movement of the support members while preventing converging longitudinal movement thereof; and,

means for mounting said movement-restricting means in a second position in which said movement-restricting means prevents diverging longitudinal movement of the support members while permitting converging longitudinal movement thereof.

9. An orthopedic apparatus as set forth in claim **7**, wherein said movement-restricting means includes:

a gear on one of said support members;

a pawl;

means for mounting said pawl in a first position on said one support member for a first biased engagement with said gear; and,

means for mounting said pawl in a second position on said one support member for a second biased engagement with said gear.

10. An orthopedic apparatus as set forth in claim **4**, wherein said rotation-preventing means comprises:

a first bore extending longitudinally within said first support member;

a second bore extending longitudinally within said second support member and axially aligned with said first bore;

a rod having opposed end portions;

means for fixing one end portion of said rod to said first bore; and,

means for slidably mounting another end portion of said rod to said second bore.

11. An orthopedic apparatus as set forth in claim **10**, wherein said adjusting member comprises a threaded second rod including first and second oppositely threaded sections.

12. An orthopedic apparatus as set forth in claim **11**, wherein said rotational-movement mounting means comprises:

a third bore extending longitudinally within said first support member; and,

a fourth bore extending longitudinally within said second support member and axially aligned with said third bore.

13. An orthopedic apparatus as set forth in claim **12**, wherein said movement-imparting means comprises:

means on said third bore for threadably engaging said first threaded section; and,

means on said fourth bore for threadably engaging said second threaded section.

14. An orthopedic apparatus as set forth in claim **10** wherein said movement-imparting means further includes means for imparting longitudinal movement to one of said support members in response to rotational movement of said adjusting member.

15. An orthopedic apparatus as set forth in claim **14**, wherein:

said adjusting member comprises a threaded second rod including first and second opposed end portions;

said rotational-movement mounting means comprises:

a. a third bore extending longitudinally within said first support member; and,

b. a fourth bore extending longitudinally within said second support member and axially aligned with said third bore; and,

said movement-imparting means comprises:

a. means on said fourth bore for threadably engaging said first end portion of said threaded second rod;

b. a first gear;

c. means mounting said first gear to said first support member for rotational movement of the first gear; and,

means mounting said second end portion of the threaded second rod within said third bore for imparting longitudinal movement to said second support member in response to rotational movement of said first gear.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 3,900,025

DATED : August 19, 1975

INVENTOR(S) : Walter P. Barnes, Jr.

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 47, delete "adaptable"; column 3, line 16, delete "and axially aligned"; column 3, line 17, after "threaded" insert --and axially aligned--; column 4, line 51, delete "and,"; column 5, line 42, change "one/eight" to --three/eighths--; column 5, line 65, after "bone" insert --growth--; column 8, line 46, insert --d.-- before "means".

Signed and Sealed this

twenty-fifth Day of *November 1975*

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks